INFO SHEET

Veterinary Services

United States Department of Agriculture

Animal and Plant Health Inspection Service

February 2000

Results of Water Testing on U.S. Beef Cow-calf Operations

A quality water supply is essential to the production of healthy cattle. Unsatisfactory water can result in poor production performance, sickness, or even death. Overall, drinking water from subsurface sources on U.S. beef cow-calf operations is of high quality. Nearly all (99.4 percent) of the water sources tested in 1997 were within Federal guidelines for acceptable nitrate levels in drinking water for livestock.

To evaluate the quality of the subsurface water available to the nation's cow-calf operations, the USDA's National Animal Health Monitoring System (NAHMS) conducted a study involving cow-calf producers from 23 of the leading cow-calf states.[1] Of those producers participating in the NAHMS Beef '97 Study, 498 had a subsurface water source for their cattle and submitted a single water sample for evaluation (Figure 1). Overall 2,713 producers with one or more beef cows participated in the NAHMS Beef '97 Study.

For this study, producers were questioned about the source of the water provided for their cattle (Figure 2). Wells were reported as the primary source of water on 82.9 percent of the operations, with springs (15.3 percent) and other sources (1.8 percent) making up the remainder. This distribution varied considerably by region of the country, with wells cited as the primary source in 94.0 percent of Northcentral operations and only 64.1 percent of those in the Southeast.

Figure 1 Number of Water Samples Tested per State

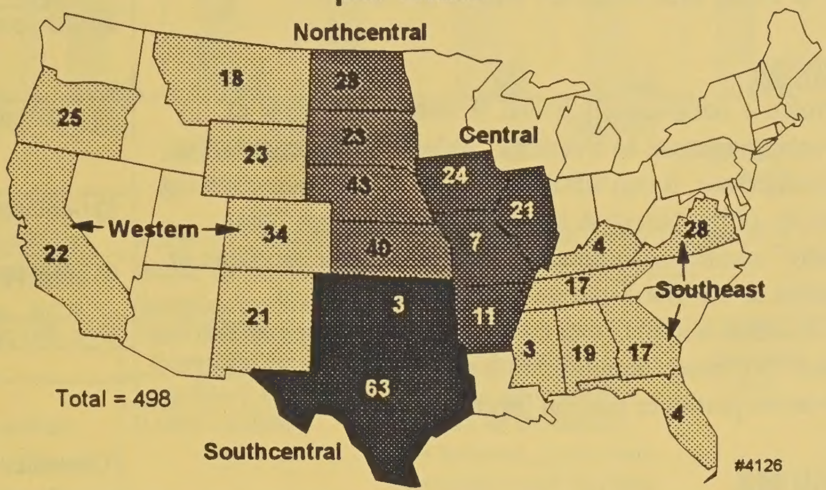
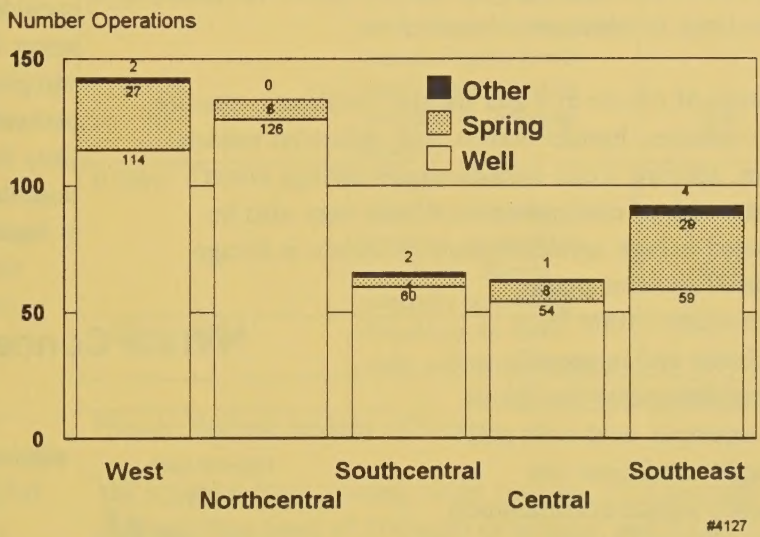


Figure 2

Water Sources By Region



The majority (76.1 percent) of the 498 water samples analyzed were obtained from a running water source such as a faucet, hose, or pipe. The remainder were collected from tanks (16.9 percent) and other sources (7.0 percent).

[1] The Beef '97 study collected management and health data on a stratified random sample of producers in 23 states: Alabama, Arkansas, California, Colorado, Florida, Georgia, Illinois, Iowa, Kansas, Kentucky, Mississippi, Missouri, Montana, Nebraska, New Mexico, North Dakota, Oklahoma, Oregon, South Dakota, Tennessee, Texas, Wyoming, and Virginia.

Table 1. Percentage of Water Samples at or Under Maximum Safe Levels for Nitrate, Nitrite, Sulfate, and Total Dissolved Solids

Water Quality Factor	Nitrite	Nitrate	Sulfate	Total Dissolved Solids
Level generally considered safe for most livestock	Less than 33 ppm*	Less than 440 ppm*	Less than 300 ppm*	Less than 0.3%* (3000 ppm)
Percentage of operations at or under maximum safe levels	100.0%	99.4%	78.9%	96.2%

* Source: National Academy of Sciences.
ppm = parts per million.

Some factors that affect water quality include levels of nitrite, nitrate, sulfate, and total dissolved solids. Levels of these components considered safe for livestock and the percentages of operations where water supplies were at or under safe levels are shown in Table 1.

Nitrite

Nitrite is occasionally found in water, but rarely at levels dangerous to livestock. When nitrite reaches the bloodstream, it can adversely affect the oxygen-carrying ability of the blood. A similar process causes "blue baby" syndrome in humans. In cattle, large amounts of nitrite in the blood can cause death if untreated. Sub-lethal amounts can cause abortions. None of the Beef '97 water samples contained detectable levels (10 or more parts per million [ppm]) of nitrite.

Nitrate

Nitrate can be converted to nitrite in the rumen of cattle. Effects of high nitrate consumption would be similar to nitrite toxicity, although a higher level of nitrate is required to induce toxicity. Nitrite is about ten times more toxic to ruminants than nitrate.

Sources of nitrate in water include fertilizers, manure, crop residues, human wastes, and industrial wastes. Older, shallow wells with damaged casings are at greater risk of contamination. Cattle may also be exposed to high concentrations of nitrate in forage material as some plants accumulate nitrate from fertilizers and in specific soil or environmental conditions. For example, acid soils and drought conditions can enhance nitrate accumulation in plants, as can cold temperatures and certain mineral deficiencies.

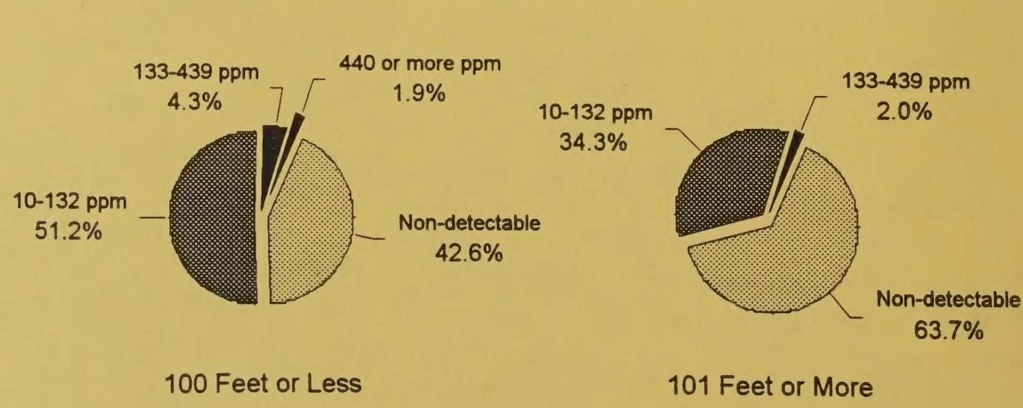
Crop plants that are known to accumulate nitrate include alfalfa, Sudan grass, and oats. A variety of weeds accumulate nitrate as well

Table 2. Concentration Levels and Effects of Nitrate in Water for Livestock and Percent of Beef '97 Samples by Concentration Level

Nitrate Concentration Levels	Effects	Percent Samples
< 10 ppm - 44 ppm	No harmful effects	80.1
45-132 ppm	Safe if diet is nutritionally balanced and low in nitrates	16.7
133-220 ppm	Could be harmful if consumed over a long period of time	0.0
221-660 ppm	Dairy cattle at risk; possible death losses	3.2
661-800 ppm	High probability of death losses; unsafe	0.0
Over 800 ppm	Do not use; unsafe	0.0
	Total	100.0

(Osweiler et al.) Producers may wish to have forage samples tested for nitrate content. Water, feed, and other sources of nitrate are additive; all sources must be considered when determining whether there is a nitrate problem. Table 2 provides guidelines of factors to consider in determining safe levels of nitrate in drinking water for livestock. While 3.2 percent of Beef '97 samples fell in the 221-660 ppm range, a small percentage (0.6 percent) exceeded safe levels for cattle (less than 440 ppm). Twenty percent of the samples tested exceeded the safe level for human infants, which is much lower (less than 45 ppm) than for cattle.

Nitrate Concentration by Well Depth



ppm = parts per million

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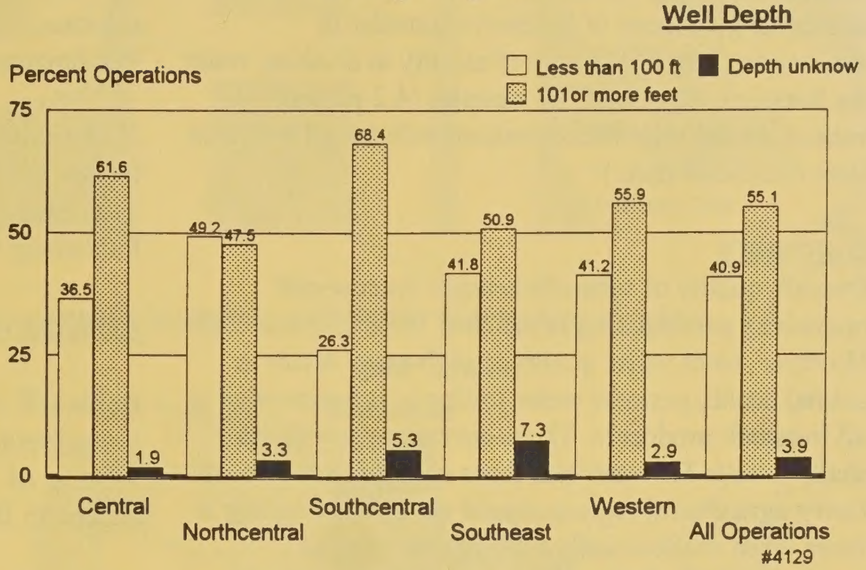
Shallow wells have a higher risk of nitrate contamination. In the Beef '97 samples, nitrate level was generally lower in deeper wells (Figure 3 on the previous page). Of wells less than or equal to 100 feet in depth, 93.8 percent had a nitrate level less than 133 ppm. Approximately 42 percent had a non-detectable level (less than 10 ppm). The 0.6 percent of samples noted in Table 1 as having nitrate levels greater than or equal to 440 ppm (n=3) were wells no more than 100 feet deep. In contrast, of the wells over 100 feet in depth, 98.0 percent had a nitrate level less than 133 ppm and 63.7 percent had a non-detectable level. Figure 4 shows the regional distribution of well depth.

Figure 4

Percent Operations with Wells by Depth and by Region



Water from well sources generally had a higher nitrate level than did water from spring sources. Of all Beef '97 samples from wells, 55.4 percent had a non-detectable level. Of all samples from springs, 69.7 percent had a non-detectable level.

Age of wells varied significantly by region. However, well age alone was not related to nitrate levels in these samples. Wells identified as being more than 25 years old were slightly more likely to be shallow than newer wells.

The U.S. Geological Survey has determined that the areas most at risk for nitrate contamination of groundwater are located primarily in the western, midwestern, and southeastern United States. In this study, nitrate levels appeared to vary regionally, but these differences were attributable to regional variation in water source. Regions in which a high proportion of the water sources were wells had higher nitrate levels than those regions relying more on springs for water.

Sulfate

Dissolved salts from rock and soil are the naturally occurring sources for sulfate in water. While adult cattle may be able to tolerate higher concentrations, levels of 300 ppm or greater may result in weight loss due to decreased feed and water intake (NAS 1974).

Twenty-one (21.1) percent of the Beef '97 samples tested exceeded the sulfate levels considered safe for all livestock. Water from tank sources generally had a higher sulfate level than water from faucet or other running water sources. Of the samples from water tanks, 32.1 percent had a sulfate level of 300 ppm or greater, and 59.5 percent had a level below 200 ppm. Of the samples from running water sources, 19.8 percent had a sulfate level of 300 ppm or greater, and 72.6 percent had a level below 200 ppm.

Table 3. Concentrations and Effects of Total Dissolved Solids in Water for Livestock and Percent of Beef '97 Samples by Concentration Level

Total Dissolved Solids Concentrations (%)*	Effects*	Percent Samples
Less than 0.1000	Okay for all livestock	70.3
0.1000 - 0.2999	Should be satisfactory for livestock, may cause temporary mild diarrhea	25.5
0.3000 - 0.4999	Should be satisfactory for livestock, may cause temporary diarrhea and/or refusal	3.0
0.5000 - 0.6999	Okay for dairy and beef cattle, sheep, swine, and horses. Higher levels should be avoided by pregnant or lactating animals.	0.6
0.7000 - 0.999	Unsatisfactory for swine, high risk for young, pregnant, or lactating ruminants. Should generally be avoided.	0.2
1.000 or higher	Should not be used under any circumstances.	0.4
	Total	100.0

*Source: National Academy of Sciences.

Total Dissolved Solids

Total dissolved solids (salinity) is a measure of the total amount of dissolved minerals in the water, including calcium and magnesium, which are largely responsible for water hardness. Moderate (0.3 to 0.5 percent) levels of solids may cause problems such as diarrhea or initial water refusal. High (0.5 to 1.0 percent) concentrations

should be avoided for pregnant or lactating cattle. Very high concentrations (greater than 1.0 percent) are not suitable under any conditions. Table 3 provides additional guidelines of factors to consider in determining desirable levels of salinity in drinking water for livestock. Few Beef '97 samples (4.2 percent) exceeded total solid concentrations safe for all livestock (less than 3000 ppm.)

Summary

Overall, quality of subsurface water on cow-calf operations participating in the Beef '97 Study was high. However, since water quality is such a key factor in animal health, periodic water testing is recommended to all livestock producers. Those operations relying on shallow wells for water and those operations located in heavy agricultural regions should concentrate testing at times when shallow wells are more likely to be contaminated by fertilizer runoff or other sources of nitrate. To decrease the chances of well contamination, producers should slope the area around the well to keep surface runoff away. Exposed parts of wells should be inspected periodically for damaged well surface seals, caps, or casings.

Interpretation of water analysis is extremely complex and is best accomplished with the assistance of a veterinarian or other professional with expertise in water quality.

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Additional Reference

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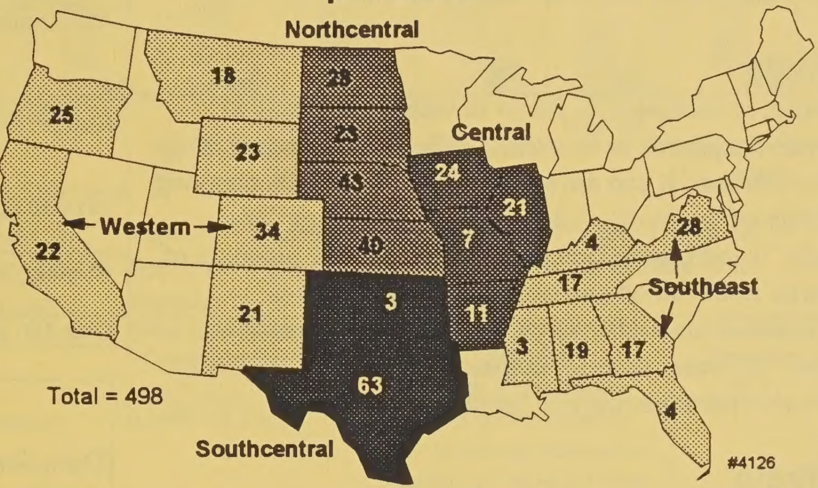

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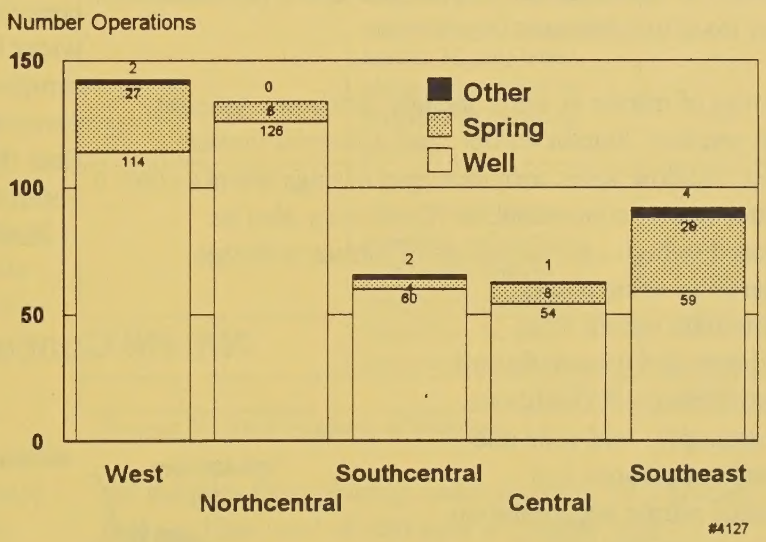

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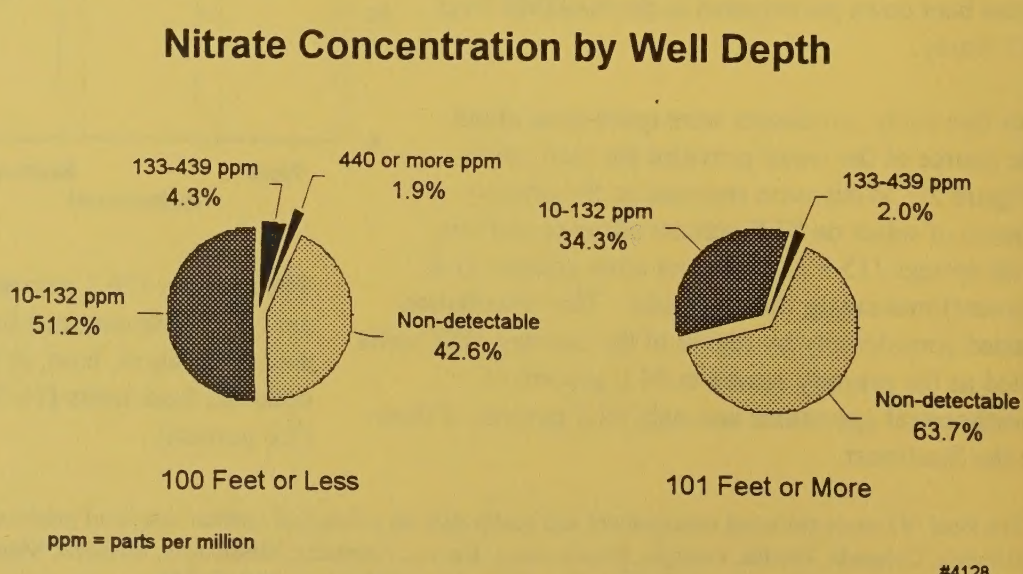

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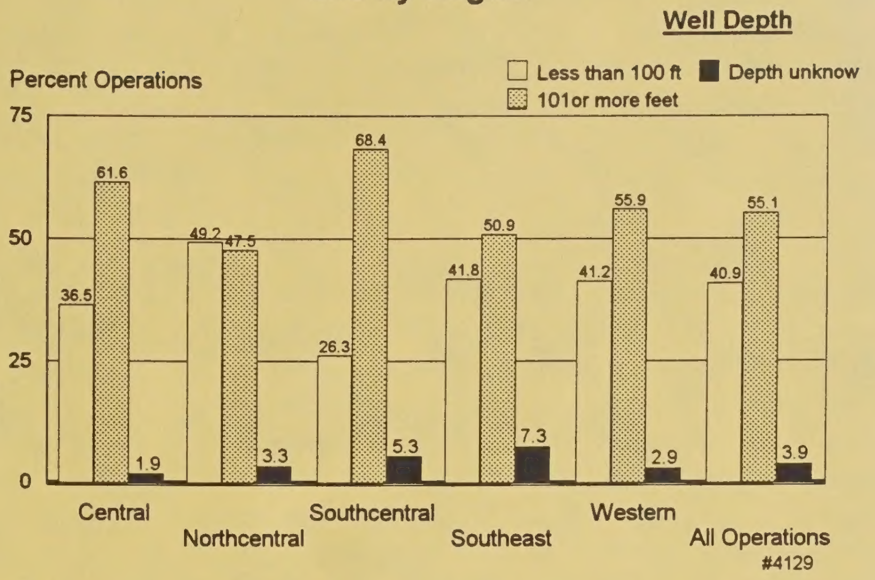

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